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ABSTRACT

This paper describes a course in which preservice elementary teachers read and discussed "The Demon-Haunted World: Science as a Candle in the Dark" by Carl Sagan. Students discussed their beliefs about the nature of science, teaching, and learning. The paper concludes that preservice teachers appeared to develop reflective and critical thinking skills as a result of participation in the course. Contains 33 references. (WRM)

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Preservice Elementary Students Meet Sagan's Demon-Haunted World

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This study documents an exploration by preservice elementary students while they worked with Carl Sagan's text The Demon-Haunted World: Science as a Candle in the Dark (1996). According to Lawson, Abraham, & Renner (1989),

> During Exploration, the students learn through their own actions and reactions in a new situation. In this phase they explore new materials and new ideas with minimal guidance. The new experience should raise questions or complexities that they cannot resolve with their accustomed ways of thinking. It should also lead to the identification of a pattern of regularity in the phenomena. (p.5)

The students where challenged to take responsibility for creating situations that would engage their classmates in discussion of both Sagan's ideas about the nature of science and their own ideas for learning and teaching science. I used ideas from the theories of Generative Processes (Wittrock, 1990) and Cultural Literacy (Bowers, 1974) to structure the class and begin to answer a question raised by Lederman, Wade, & Bell (1998) about the nature of science. "What are the limits of the person's understandings and how do their understandings affect their choices and behaviors" (p. 610)? By capturing students' well-remembered events (Carter, 1994) of their work with Sagan's text, this study begins to answer the question asked by Lederman et al.

Factors that Influence Generative Processes

In this paper, understanding, comprehension and perception are assumed to be generative processes (Gibson, 1969; Wittrock, 1990)). I will refer to them as point of view. The generative processes, according to Wittrock, involves one in relating others' inferences (from text or orally) to one's beliefs and experiences. This model suggests that effort, attention and memory influence generation. In terms of attention and effort,

one apparently needs an on-going willingness to propose new relationships using his/her beliefs and relevant, verbal and imaginal inferences. According to Wittrock, the generative processes might be cyclic, "the stored memories and information processing strategies of our cognitive systems interact with the sensory information received from the environment, they selectively [emphasis added] attend to this information, relate it to memory, and actively construct meaning for it" (p. 348).

Apparently, we use our beliefs to decide what is relevant, in turn what we find relevant influences our beliefs. Another factor that might influence the generative processes was described almost 25 years ago by Bowers (1974). In Cultural Literacy for Freedom, Bowers explained how one might develop a point of view (one's reality). He used Berger's and Luckman's (1967) stages of socialization, including externalization, objectivation, and internalization. Externalization involves one in "an [expressive] act in a form that allows it to get into social communication" (Bowers, p. 31). Bowers explained that the act might be expressive by showing one's point of view:

> The everyday lives of most people involve encountering a reality already structured for them by society. What they communicate is thus largely shaped by what the significant other [parents, teachers, peers, etc.] already legitimized, with the consequence that what they externalize through communicative acts may be only a restatement of already shared and socially legitimized realities. (p. 31)

Influential people, groups of people, and social forces like the media are potentially significant others. The influence from significant others (externalization) might result in what Bowers discussed as objectivation. Objectivation occurs when an act and its motives (from a parent, teacher, coach, other students, etc) are considered

and transformed into a student's reality "without looking at the questions related to motive or level of understanding that caused the original interpretation to be made" (Bowers, p. 32).

The process of internalization happens after one objectifies another's point of view. Internalization is evident by the way one explains or justifies their actions (e.g., with regards to science teachers start with Tobin & McRobbie, 1996). Bowers (1974) did note that "the process of internalizing a social definition is not a mechanistic one, but must be continually sustained through conversation and negotiation with the significant other" (p. 34). Bowers suggested that curricular concerns should focus on helping students understand their taken-for-grantedness, specifically their culture's assumptions and myths. Bowers referred to taken-for-grantedness as a lack of awareness for the "socially congruent nature" (p. 15) of one's point of view. In order for students to focus on their taken-for-grantedness, Bowers described a curriculum designed for students to explore their own questions concerning their beliefs and those provided by the culture. By focusing on the students' experience and using inferences from their point of view, the cultures' hidden assumptions and historical roots can be examined.

Assumptions of the Study

This section discusses assumptions for the teaching and research methods used and is divided into the following three sections: Comparing Beliefs and Authenticity, Discussing Representations and Contextuality, and Narrating and Integration. The first section, Comparing Beliefs and Authenticity, briefly discusses the purpose for using Sagan's text (1996), The Demon-Haunted World. The Discussing Representations and Contextuality section explains what students did in class during the semester and the

Narrating and Integration section clarifies the methods used to ascertain and present evidence in the Results Section.

Comparing Beliefs and Authenticity

The course in which these students participated was not intended to be a traditional methods course. I did not play the role of dispensing or even engaging and then explaining to students some of the more powerful techniques identified in the research literature. I assumed these future teachers' points of view about learning and teaching science was similar to their experiences and beliefs as students (Tobin & McRobbie, 1996).

Instead, I was looking for a text that influences future teachers' thinking about science curriculum. Bowers (1974) suggested that one might "include a [curricular] component dealing with another culture. Part of the difficulty in becoming aware of one's own culture is that a basis of comparison is often lacking" (p.119). In The Demon-Haunted World, Sagan stated what cultures he intended to compare:

> Pseudoscience is embraced, it might be argued, in exact proportion as real science is misunderstood-except that the language breaks down here. If you've never heard of science (to say nothing of how it works), you can hardly be aware you're embracing pseudoscience. You're simply thinking in one of the ways that humans always have. (p. 15)

Sagan's text presents preservice students with opposing views of events of what many might think reality. I assumed the events Sagan discussed are compelling and controversial for students (for similar logic see Meadows & Howley, 1998). By putting their beliefs about science and learning "on the table," I hoped students would

understand they have a point of view. I considered the forum created by students discussing their beliefs authentic. Brown, Collins, and Duguid (1989) suggested that authentic activities are purposeful attempts to mediate uncertainty through dialog and interaction with tools.

Discussing Representations and Contextuality

Thirty-seven elementary science methods students made sense of The Demon-Haunted World, by representing and discussing their responses to the following topics: 1) UFOs, aliens, dragons & witches; 2) skeptical thinking; 3) creativity; 4) science v. pseudoscience; and 5) a broad audience. Small groups of students designed activities for the whole class to participate. I assumed these activities provided students the opportunity to "invent a model or explanation for it [science curriculum] that organizes its parts in a way that makes sense to us, that fits our logic and our world knowledge" (Wittrock, 1990, p. 353).

I assumed that representing one's beliefs an expressive act (Bowers, 1974) and thus a tool. According to Gibson (1969), representations are planned perceptions of objects and events. She suggested that perception is used to convert uncertainty into a more orderly state. Gibson also believed perception moves from a fixed to a more exploratory, but selective activity. Students finding that they have different points of view might create for students a sense of uncertainty and the uncertainty of that situation might influence more complex thought processing.

Throughout the entire semester, students discussed their representations. I assumed that their dialog divulges commitment to their points of view. The process of moving "back and forth from thought to word and from word to thought" (Vygotsky, 1992, p. 218) provides an opportunity for students to relate their actions with their

beliefs and to make comparisons. These comparisons influence one's awareness of agreement-disagreement and understanding-misunderstanding (Miell & Miell, 1986) about the points of view they use. Perhaps that is why Howe advised (1996) that students should form problems themselves, when she wrote:

> Concepts are formed, he [Vygotsky] believed, not by an interplay of associations or by repeated experience but by an intellectual operation in which such mental functions as memory, attention, and inference participate, and in which language is the guide; putting things into words centers attention, clarifies thinking, provides a means of symbolizing thought, and is an integral part of the process of concept formation. The development of conscious awareness through the use of language propels thinking forward toward conceptual understanding. (p. 41)

According to Howe (1996), dialog is thinking and that interaction creates context.

> A sociocultural approach to instruction relies on language as a tool to support and promote thinking, using it as a means to stimulate pupils to reflect and explain in order to understand how their experiences and their context-bound knowledge fit into a larger system. (p. 47)

Narrating and Integration

To illuminate the idea of belief for students, both Freire's (1973) and Greeno's (1989) assumptions about thinking organized my role and my expectations for students. The class met one night a week for a semester. Approximately 75% of the semester, small groups of students shared direct responsibility for creating dialog about Sagan's text with the rest of the class of students. The following syllabus excerpt shows this assignment:

> Use Sagan's text in concert with any other ideas (e.g., Moline's text (1995)) to create a context for class conversation. Your group will be self-selected but even in numbers. Dialog should last two class periods. How your group chooses to create the context is open. Your group might consider What perceptions already exist? and What stimulates dialog?

This rather open-ended task gave students the freedom and its resulting uncertainty to create their own activities. My assumption was based on Freire's suggestion that "Integration with one's context, as distinguished from adaptation, is a distinctively human activity. Integration results from the capacity to adapt oneself to reality plus the critical capacity to make choices and to transform that reality" (p. 4).

I took on the task of shifting the dialog by constantly asking students for their inferences about learning and teaching (e.g., How does that pertain to teaching? You mean like when you were a student in high school? or Why would you do it that way?). I was directed by the following suggestion from Greeno (1989) "According to the assumption of situated cognition, most cognitive activity occurs in direct interaction with a situation, rather than being mediated by cognitive representations [point of view]. Cognitive representations play a role when something goes wrong" (p. 139). In this class, I hoped the significant other, as described by Bowers (1974), was the students themselves. Goodman (1988) provided the following concise explanation for my assumption:

> Reflection must include more than just what individuals believe, (it must) help students consider the meaning they give to their words, how these meanings may differ among a given group of individuals, and what experiences influence their ideas and actions. (p 134)

At the beginning of each class, I used my notes from the previous sessions to share my recollections and provide students the opportunity to share their responses, questions, concerns, or new issues. This cyclic teaching process (going from observation to inference to observation) used with these students resembles the research methodology discussed by Glaser & Strauss (1967, chap 2). Throughout the semester, students were encouraged to note their responses to the events and issues raised in class to help them build narratives that they would submit at the end of the semester. I assumed these narratives subjective data "experienced from the student's side" (Bowers, 1974, p. 21). In reference to constructing and telling their stories about events, Carter (1993) states "authors attempt to convey their intentions by selecting incidents and details, arranging time and sequence, and employing a variety of codes and conventions that exist in a culture" (p. 6).

From my point of view, this was a challenging assignment for students. I did not give tests or use grades in any way. Students were given the freedom to take an issue (e.g., skeptical thinking), use their experiences and conjure activities they thought would stimulate dialog with others. By using beliefs held true by many, then looking at those beliefs from a differing point of view, Sagan created a tension for his readers. For example, in the chapter, "The Fine Art of Baloney Detection", in reference to what not to do (i.e., inconsistency), he states that many

> Attribute the declining life expectancy in the former Soviet Union to the failures of communism many years ago, but never attribute the high infant mortality rate in the United States (now highest of the major industrial nations) to the failures of capitalism. (p. 214)

While using perhaps controversial examples, Sagan provides the reader with questions that exemplify the nature of both scientific thinking and using evidence.

Students were exposed to the idea that their beliefs influence their points of view. They were encouraged to construct and use many types of representations as well as invited to participate in dialog about those representations. Perhaps the events of this class were different from many classes that these students commonly experience. While making a case for the value of listening to teacher's narratives, Carter (1993) described the importance classroom events play for the novice teacher:

> teaching in schools is experienced as complex social events and the acquisition of expertise in teaching is, in essence, the acquisition of event-structured knowledge. Expert teachers, in other words, have a rich store of situated or storied knowledge of curriculum content, classroom social processes, academic tasks, and students' understandings and intentions. Novices, who lack this situated knowledge, often struggle to make sense of classroom events, and in this struggle, their knowledge is shaped in fundamental ways, that is, their stories are formed. A focus on events, therefore, is likely to capture a fundamental process going on as novices learn to teach. (p. 7)

Attending to Carter's words (1993), I assumed the students' narratives represented a "well remembered episode that a student observes in a school situation and considers, for his or her own reasons, especially salient or memorable" (p. 7).

While reading the students' narratives, I constructed Table 1 to help identify what students thought salient. The table in one way shows what students wrote about in their narratives (See Table 1). If they talked about beliefs in general or their personal beliefs, it was noted. If they talked about their notions of teaching (Exploratory Teaching) that too was noted. Consequently, one student's narrative might be represented in more than one category.

[Table 1 Here]

As a whole, students seemed to find the topic of beliefs to be the most captivating. They seemed to connect their notions about teaching and thinking to beliefs. Carter's (1993) second premise for the importance of well-remembered events seems pertinent:

> knowledge is organized into explanatory frameworks, and, in turn, serves as an interpretive lens in comprehending one's experience. Thus, by recording what events are storied by novices, especially over time, it should be possible to gain insights into what they know, how their knowledge is organized, and how their knowledge changes with additional experiences of watching and doing [in this case, science] teaching. p. 7

I used narrative analysis to reconstruct what happened during the semester. Riessman (1993) described this method as a "talk organized around consequential events. A teller in a conversation takes a listener into a past time or 'world' and recapitulates what happened to make a point" (p. 3).

Research Questions

This study uses preservice elementary teachers' responses to The Demon-Haunted World (Sagan, 1996) to illuminate their beliefs for learning and teaching science. The research questions are as follows:

1) How did students' become aware of point of view? and

2) How did the setting influence students' points of view for teaching and learning science?

Results

This section shows the well-remembered events students documented including their awareness of beliefs, their beliefs about science and teaching in particular, and a curiosity they initiated for both critical thinking and using student-centered exploration. The research section also uses Bowers' (1974), Greeno's (1989) and others' work to interpret students' artifacts. This section is divided into two parts. The first section, A Walk Around the Block, explores a teacher-directed activity. The second section, Students and The Demon Haunted World, represents student-directed activities. Both sections are composed using artifacts including samples of drawings students initiated and discussed, excerpts from their two-page narratives, as well as my notes and recollections.

A Walk Around the Block

The month before the student-directed sessions introduced a framework for the rest of the semester. I used Chandler's and Nelson's (1998) "Walk Around the Block" (WAB) to introduce some of Goodman's (1968) notions about world-making. Goodman described world-making as "how worlds are made, tested and known" (p. 7). He stated that composing, decomposing, applying of labels, weighting, ordering, deleting and supplementing are tools humans use to create their worlds (points of view). Goodman related the nature of investigating to the generative processes when he said "Discovering laws involves drafting them. Recognizing patterns is very much a matter of inventing and imposing them. Comprehension and creation go on together" (p. 22).

The WAB is a simple activity. Students are asked to walk around a city block a minimum of three times and represent their experience. They are not directed to attend to any particular characteristic of the block, but are encouraged to let their experience,

beliefs and resulting questions influence the making of their representations. According to Bowers (1974), creating situations in which students inspect their beliefs "involve[s] eliciting from the students a description (not an explanation that would generally represent something socially acquired) of personal space" (p. 116). I hoped the dialog resulting from the presentations of their WAB representations influenced students' awareness of their world-making, specifically their taken-for grantedness.

Students walked around a city block (WAB) next to the university. No directions for any particular characteristic of the block were given except to be open to the potential of the experience. One comment typified students' initial responses to the task and epitomizes Novak's warning for the "pernicious character of rote learning" (1990, p. 43).

> An assignment with no guidelines, rules, or clue on how [to engage]. Not one person in the class was certain what to do for their [sic] representation. We all developed an idea of what you wanted, but we never knew exactly what you expected. You gave us the chance to do whatever we could imagine, but we weren't ready for that type of freedom.

Students developed representations of their experience; these included: a poem, a histogram, an audio tape, a collage, and numerous maps. Subsequently, they made presentations. The idea was for students to "explore the full range of responses from all the students who shared the experience" (Bowers, 1974, p. 21). During the presentations each individual or group of students answered the following questions: What is enough to get the meaning across?, What does your representation say?, What did you capture?, and What symbols did you use? These questions influenced students'

engagement with each others' images of their walk. Students justified the fact that most of the representations (5/8) were maps:

> We were not told how to make the representation. My group made it how we believed a "science teacher" would want us to make it, with precision. This consisted of quantifying everything. We have been told how to think for so long, that it has become a part of our mind set. How then do we learn how to think critically?

The discussion of students' representations illuminated two interesting beliefs, both influences one's teaching and more specifically; one's teaching of science. First, if they have the opportunity to count, students think precision is maintained. Embedded in this notion is confusion among the concepts of concreteness, abstraction, and objectivity (Nelson & Chandler, 1999). Students counted only certain aspects of the block to make their representations concrete. Actually, they were trying to abstract patterns from those events, a phenomenon Gibson (1969) called perception.

Students' strategies to capture concreteness is evident in teacher assessment practices (Eisner, 1994). Earlier, Bowers (1974) provided an explanation for students' belief. He wrote that "[In our culture] Measurement is considered the only legitimate means for determining whether learning has taken place, consequently only measurable phenomena are considered real to the educator" (p. 92). Eisner called this tendency precise objectivity (p. 188).

Precise objectivity might also influence student's point of view for learning and teaching science. The following Nature of Science standard raises some questions: students will "understand that science is ongoing and inventive, and that scientific understandings have changed over time as new evidence is found" (Governor's Council on Model Academic Standards, 1998, p. 59). Is measurement the only form of

observation used in the sciences? Does inventive only mean a transformation through mathematical operations? Do people or scientists for that matter really use only mathematical operations to represent events? If so, is the process they use only mechanical? For these students perhaps, the following objective written by Robinson (1998) is initially more appropriate "Understand the relationship of theory to observations-without theory man does not know what to observe" (p. 627).

The second issue is captured by the following student's comment "We think first the knowledge base must be built before children can learn." This notion emerged from a "students doing what they are told" discussion. Typically, students are given information (facts, concepts, principles, and theories), hopefully so "that understanding would just occur when enough facts had been memorized" (Tobin & McRobbie, 1996, p. 236). During this "doing what they are told" discussion, students used a diving board as a metaphor for learning, maintaining that one must build the diving board before learning (jumping off) can take place.

These students also shared their strategies for surviving experiences while their own diving board was being built for them. They confessed that they find out what the teacher wants, then they do the minimum to reach that expectation. The result of students' strategy might explain what is usually discussed in measurement and evaluation texts with regards to validity (fairness or certainty) and reliability (consistency). While discussing the process of testing, measurement and evaluation texts typically describe relationships among classroom and student variables and test scores. One relationship is the inverse relationship between time passed and students' test scores. Students seem to quickly forget what was covered. We used the diving board metaphor for the rest of the semester to remind each other of that belief.

The WAB did re-introduce knowledge building and invited students to begin to think critically in a classroom situation. One student wrote

> Many of us were uncomfortable doing this [WAB] and were not sure what was expected of us, so we fell back on the beliefs of what we felt the teacher wanted from our previous classroom experiences. Further examining this we discovered that it is our beliefs that influence how we see the world around us.

Greeno (1989) said critical thinking "has to do with whether individuals think reflectively, rather than simply accepting statements and carrying out procedures without significant understanding and evaluation" (p. 139). He attributed critical thinking to the uncertainty of situations and one's beliefs. Greeno also raised the possibility that critical thinking "is more a social phenomenon than it is a characteristic of individuals" (p. 139).

Students and The Demon Haunted-World

UFOs, Aliens, Dragons, Witches and Beliefs

After the WAB activities, each group of students introduced their specific topics for discussion. Students worked in groups of approximately seven and assumed responsibility for one of the following: 1) UFOs, aliens, dragons & witches; 2) skeptical thinking; 3) creativity; 4) science v. pseudoscience; and 5) a broad audience. A student briefly described her expectations and subsequent realizations. She said, "When I first saw the topic of UFOs, aliens, dragons, and witches, I thought we would be talking about what we thought they were. I soon learned the topic went much deeper than just describing them."

One group introduced the topic for discussion by asking the class to divide a sheet of paper into four sections then draw an image of a UFO, an alien, a dragon, and a

witch. They then distributed a set of UFO etc. drawings that pre-school children constructed before class (See Figurs 1 & 2). Figure 1 represents a future teacher's depiction of aliens and Figure 2 shows a preschooler's (4 years old) idea. Both representations capture aliens as glabrous with large, rather dark eyes.

[Figure 1 & 2 here]

Students' discussion after this activity centered on the similarities of the drawings and why those similarities occurred. One student wrote:

> During our discussion about UFO's, aliens, dragons and witches I was extremely shocked with our results. I was very surprised with the fact that after we all drew pictures of what we thought these things looked like, they were all similar in some way. Even compared to the children's drawings of the same things they were alike in many ways. This proves that we all have the same sort of belief of these things.

Subsequently, students described their notions of belief, and they discussed the ramifications and possible sources of beliefs. One wrote "It is easy to say what we believe but it is a lot more difficult to explain why." Another, "People are too tempted to believe and all too often believe without knowing." Students did marvel at the power of beliefs. One wrote:

> Sometimes I would wonder if I were getting anything from the discussion, but I needed to take a step back the next day and reflect to understand the meaning behind the discussion. I developed the ability to look at the content and see how my beliefs play into it. There is that magic word that caused so much frustration

and debate in discussion (Beliefs). Not only is it hard to define, but it is involved in everything that we see and do, whether we realize it or not.

Their discussion connected the emergence and strength of beliefs to uncertainty and perception (as discussed by Gibson, 1969) and to a recursive quality discussed by Miell & Miell (1986). In this class, "he said that she said that someone else said" (p. 30) quality was often refered to by the students as they. Miell and Miell represented this interplay as A -- B -- X (p. 30). This symbol system denotes X as an event; where A states a view for B's thinking about X). For example, one student wrote:

> Fear of the unknown sets the stage for beliefs. The unknown helps us become aware of our beliefs. Trust goes along with uncertainty. Trust is an issue, people listen to people they trust. We hear what people say and we trust them, this goes along with beliefs. We hang on to our beliefs because once they are gone we don't know what to do. Beliefs put pressure on things. Beliefs are so strong because we start seeing what our beliefs tell us to see.

This metacognitive interaction supplies an opportunity for people to examine their beliefs (Langford, 1986). Another student wrote:

> Throughout the book, Sagan shows different beliefs and disproves them. In class we were able to express our beliefs towards the topics and issues raised in The Demon Haunted World, as well as matters regarding us as aspiring teachers. This helped me get in touch with my own beliefs. I was also able to see other points of view, which showed me different ways to look at things. I started to understand how and why people believe in the things they do. Our beliefs are so strong that they sometimes take over and impede our critical thinking abilities. For example as students, we were mass hallucinated into believing that everything a teacher says is true.

For some students, the UFOs, etc. dialog was a well-remembered event. Students explained Sagan's concept of mass hallucination, how one might be influenced and why.

> As an activity, we all drew pictures of what a UFO, an alien, a dragon, and a witch look like to us. Overall, we all had very similar pictures. Then we asked why that was. After talking about this, the subject of mass hallucination came up. When I hear the words mass hallucination I think of everyone doing the same thing (sort of copying).

> Mass hallucination is a concept where all people have the same image of a particular item, event, or action. This may be explained through things like the media or even through customs and traditions.

> Beliefs are very hard to change. They are things that give us comfort, to go against our beliefs would mean giving up that level of comfort. The reason people do things a certain way is because they are comfortable with that method.

In concert, the drawing activity, dialog, and Sagan's text provided an opportunity for students to put together the concept of belief or presupposition (Cobern, 1991). Bowers (1974) explains:

> When the curriculum includes a unit on another culture, it becomes easier for a student to "see" his [sic] own culture. The purpose of the cross-culture perspective is to provide a means of helping the student to understand another view of reality and thus to be able to come back to his own in a different frame of mind. (p. 120)

For the remainder of the semester, any time a student or I used the term "they" (e.g., they said that . . .) others asked for a clarification of they.

Beliefs, Skepticism, Creativity and Critical Thinking

The group of students responsible for the skepticism topic used an Ouija session as an introduction. Subsequently, students told stories about ghost sightings and other weird phenomena. Students were polarized as to who believed, who didn't. One later wrote, "I think that the most important thing that this class gave me was the reinforcement that everyone has their own beliefs. Some were downright amusing, such as the lesson on the Ouija board."

Students did realize how diverse their beliefs were, and "how strongly they like to talk about their beliefs". Using Sagan, one student elaborated her definition of skepticism and wrote about its connections with beliefs:

> Through discussion in class, we came to the conclusion that skeptical thinking is not always negative. I think that it is taking whatever it is you are looking at and cutting it open and looking at it. I think that Sagan was telling us to think skeptically in everything we do. He wanted us to look at our beliefs and the beliefs of others in a skeptical light. He does not want us to always blindly believe what we are told.

Students introduced creativity by having the class make something new out of a sheet of paper. Then students chose which items were the most creative and explained their reasoning. This discussion was chaotic. Students suggested qualities they attribute to creativity, such as originality, a combination of simplicity and complexity, expressiveness, and imagination. Someone asked how creativity might be graded.

Perhaps, because grading seemed an ambiguous task, no one felt comfortable with his/her notions of creativity. Out of this discomfort, students described a situation in which creativity might take place. One student wrote

> It's amazing that people are aware of creativity yet have only abundant abstract descriptions. A definition molded to include a variety of persons' conceptualization of creativity is virtually impossible and improbable. However creativity exists and is determined both valuable and necessary. I don't know how long it might take me, or if the point would have ever been reached, about the opportunity involved in creativity. Only when a child, or an adult, feels secure and confident to take risks is there even a chance for creativity.

Teaching a Broad Audience

The last issue raised at the end of the semester, Teaching A Broad Audience, seemed to carry with it notions from previous events, the "students doing what they are told" and "how strongly they like to talk about their beliefs" dialogs. These dialogs apparently influenced students "to think dialectically where a tension emerges between the student's analysis of historical developments and the existential questions that have emerged" (Bowers, 1974, p. 119). Several students acknowledged their beliefs and how those beliefs influenced their receptivity to new ideas about science curriculum.

> [In other classes] I have learned of some alternative approaches and new methods of teaching and thinking and though I see value in them, I haven't always been totally open to them because my beliefs about these areas are deeply rooted in my own educational experiences. My belief tells me "This is the way it has always been so this is the way it should continue to be, whether it works or not". Or even worse, it brainwashes me into believing that something works when in reality it does not. The only reason I hold on to these ways of thinking is my own fear of letting go of my beliefs. But to teach students to be creative and take risks, teachers should be willing to do the same.

As Glaser & Strauss (1967) suggested with regards to generated theory, only theory can replace theory. Some students wrote as if perhaps they found tools they had lost, uncertainty, risk-taking, and exploration of beliefs, and perhaps began to rebuild the diving board metaphor:

> I have learned just how important it is to know how to think critically, and that most of us really do not know how. Science, however, can be used as a "tool" that helps teach us how to think. Sagan regards children as natural born scientists. They are curious about the world and want to know how and why the

world is the way it is. Why then are we so often discouraged by science? The "tools" were taken away from us. The wonder and joy of discovery were taken out of science because all of the answers were provided. Critical thinking is fostered in an environment where children are not always given the answers and they are allowed to take risks. Giving students the tools to think means teaching them to recognize their own beliefs and allowing them to search for the truth by looking at the evidence and drawing a conclusion.

It did not take our class long to realize that as small children, students are often interested in proving their own ideas and studying why and how things occur. They are intrigued by mystery and things they do not understand. We defined science as challenging our beliefs. To incorporate this into the classroom, we need to let our students take charge of their own learning and challenge them to test their beliefs on how the world works. It [science] is the process of getting them to think about why and how things occur.

Science V. Pseudoscience

What I tried to do with this group of students was to "design a social environment in which reflection and evaluation of ideas are encouraged, rewarded, and expected as part of the normal interactive activity of the group" (Greeno, 1989, p. 139). Did that happen? According to one student

The format of this class was challenging because it allowed me to test my beliefs. It also encouraged me to think about why I thought the way I did because answers and thoughts were not just accepted they were analyzed. A lot of what I

learned in this class had to do with listening to the way other people think and processed information.

How students handled The Demon Haunted World might be represented by one student's comment, "Instead of learning how to do a lab with students, we discussed what we think science is." Uncertainty, making public one's thoughts (representation) and dialog were common to the students' experiences. The variable that seemed to influence students' willingness to work with Sagan's text was described by Wittrock (1990). He said, "In generative learning, students' knowledge, experience, and learning strategies are crucially important because, as strange as it may seem, answers given to learners must still be generated by them before they can comprehend them" (p. 353). A student shared perhaps a fairly accurate idea of the tentative nature of learning.

> I was not presented with the how and why, expected to soak it all up, and then to immediately apply the put forth material. All of that is what I anticipated, all of that is what I've monotonously sat through time and again. What I wondered most is if that is the optimal opportunity in which individuals learn. Or if perhaps there is a lot more involved in the act of internalizing and owning knowledge. My biggest unanswered notion is understanding whether or not it is the how data is presented to me that matters most or if it is where I am personally in life that is most influential. Will I again visit the conversations and situations experienced throughout this class in five years and assume new interpretations and expanded notions? I'm rather confident in an affirmative response but then profoundly distraught at the idea of having to labor over them again with yet another set of mismatched conclusions. Possibly this is the essence of learning and is precisely the way people really understand the purpose and process

> hidden in the shadows of facts and obscure data. Only by probing deeper into an issue can the surface descriptions make the most sense, can we truly internalize an issue and make it our own.

Sagan (1996) seems to agree with this student, when he wrote the following about the nature of science:

> Pseudoscience differs from erroneous science. Science thrives on errors, cutting them away one by one. False conclusions are drawn all the time, but they are drawn tentatively. Hypotheses are framed so they are capable of being disproved. A succession of alternative hypotheses is confronted by experiment and observation. Science gropes and staggers toward improved understanding. (p. 20)

Students had a difficult time during the science v. pseudoscience sessions. At least, they did consider that in a general sense science was about disproving beliefs. Students did raise an interesting question, I could not answer. When does one use science and when does one use pseudoscience?

Conclusion

This study explores preservice elementary students' response to working with a text that presented points of view respective of at least some aspects of the nature of science. Sagan's narrative takes a skeptical approach to many of today's social phenomena. This approach provides students with the challenge to think about the opportunity provided by asking questions, considering one's points of view, and realizing others points of view. Careful scrutiny of Sagan's narrative also shows the creativity necessary to take a stance with a skeptical point of view, particularly how questions provide an opportunity for one to search for and select evidence.

How did students' become aware of point of view?

Students seemed to choose initially a passive approach to the activities during this class. Their approach and subsequent discussion illuminated points of view that were influenced by their interpretation of previous events. For example, the WAB perhaps reminded students of the influence their past events provided and the resulting belief about learning they took for granted.

> Many of us were uncomfortable doing this [WAB] and were not sure what was expected of us, so we fell back on the beliefs of what we felt the teacher wanted from our previous classroom experiences. Further examining this we discovered that it is our beliefs that influence how we see the world around us.

The activities that students designed were successful. In all cases, students seemed quite capable of creating situations that were perplexing and engaging for others. Students talked about what they believed and at least in some cases came to realize their beliefs were similar to an "invisible" other. For example, the activity using the UFOs, aliens, dragons and witches drawings influenced a discussion that caused students to write about what they know and why.

> As an activity, we all drew pictures of what a UFO, an alien, a dragon, and a witch look like to us. Overall, we all had very similar pictures. Then we asked why that was. After talking about this, the subject of mass hallucination came up. When I hear the words mass hallucination I think of everyone doing the same thing (sort of copying).

Perhaps because the class consisted of 37 students, in some cases with differing points of view, students naturally explained reasons for their differences. Those differences caused students to ask each other questions and to listen.

Through discussion in class, we came to the conclusion that skeptical thinking is not always negative. I think that it is taking whatever it is you are looking at and cutting it open and looking at it. I think that Sagan was telling us to think skeptically in everything we do. He wanted us to look at our beliefs and the beliefs of others in a skeptical light. He does not want us to always blindly believe what we are told.

How did the setting influence students' points of view?

In their narratives, students seemed to use the ideas they generated to talk about how they might teach. For example the "students doing what they are told" and "how strongly they like to talk about their beliefs" dialogs were well-remembered events that provided students the opportunity to imagine new possibilities for their teaching.

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Table 1

Issues of which students wrote in their narratives

Issues	Number (N = 37)	Percent %
Beliefs	21	58
Creativity	10	28
Exploratory Teaching	9	25
Drawings of UFOs, etc.	7	19
Uncertainty	5	14
Walk Around the Block	5	14
Skeptical	5	14
Listening to Others	2	6

Figure 1 A preservice students' representation of an alien.

Figure 2.A pre-school students' representation of an alien.